

Space Weather Technical Forecast

Issued on Sunday 23 March 2025 at 00:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of isolated M-class flares. G1-G2 storms possible each day. Chance of G3 day 1 (23 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with occasional C-flares. There are currently thirteen sunspots on the Earth facing disc. Despite the large amount of sunspots, the vast majority are relatively small and magnetically simple and either stable or in slight decay. AR4036, in the northwest quadrant, remains the most significant group having displayed quite rapid growth in the past 24 hours, with multiple penumbra having developed in its trailing portion.

A faint but quite wide angle CME was observed leaving the sun following a filament lift-off from just south and east of centre disc, between 22/1300-1500 UTC. This is being analysed for any potential Earth-directed component. No other Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were indicative of CME and coronal hole influences. Peak speeds of 520-525km/s were observed around 22/0100 UTC and 22/1900 UTC, with an erratic reduction 430-480km/s in-between. Density varied between above average and average. Interplanetary Magnetic Field, Bt, was initially strong but very gradually declined to current weak levels. The north-south component, Bz, followed a similar pattern to the IMF, with early peaks of +14nT to -18nT, before gradually easing and remaining largely negative. Phi angle was mostly negative (towards the sun). Geomagnetic activity was G1-G2/Minor-Moderate storm (Kp 5 to 6) between 22/0000-0600UTC. A brief reduction to Quiet (Kp 1) followed 22/0600-0900 UTC, with Active or Unsettled (Kp 3 to 4) levels thereafter.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 2.12e6 at 23/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity is expected, with a chance of further isolated M-class flares.

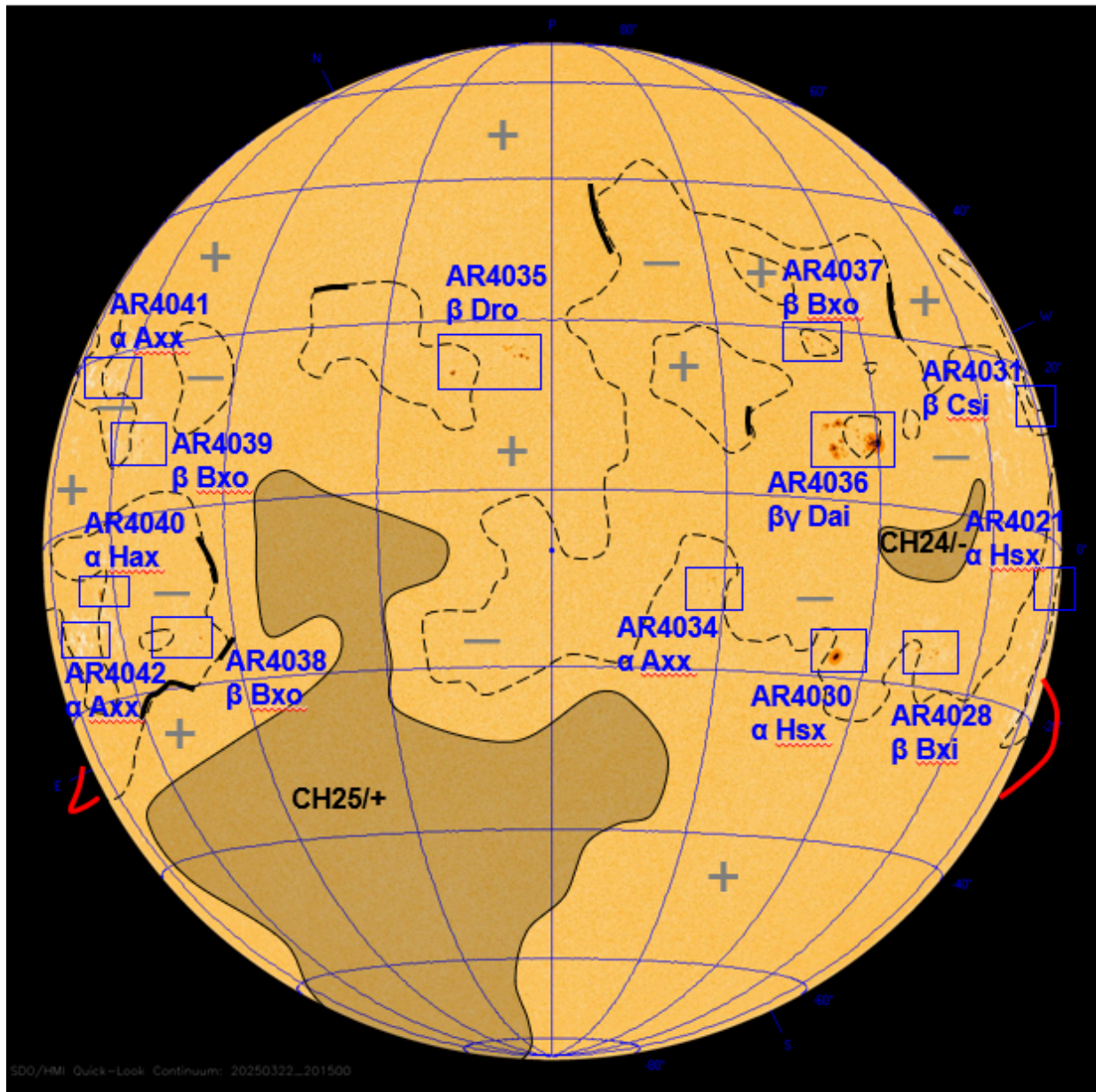
Solar Wind / Geomagnetic Activity: Two CMEs feature in the forecast, with a chance of further weak transients. One CME from 19 Mar may yet still give a glancing blow at Earth at first on day 1 (23 Mar). The second was a faint halo CME which is likely to arrive during the the first half of day 1 (23 Mar).

Otherwise, solar winds are expected to continue slightly elevated to elevated initially due to CH24/- influence, but are likely to become enhanced further with the CME arrival, perhaps reaching strong levels. Solar winds should then gradually decline through 24 and 25 Mar, before the potential arrival of the HSS from the large CH25/+ from late 25 into 26 Mar.

Unsettled to Active geomagnetic conditions are likely initially, before rising to G1/Minor to G3/Strong storming due to likely combined CH HSS and CME influences through day 1 (23 Mar). Geomagnetic activity is then expected to reduce back to Unsettled to Active, with a chance of G1-G2/Minor to Moderate Storms days 2 to 4 (Mar 24 to 26) initially from residual CME effects, then latterly from the HSS from CH25/+.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at largely background levels until later in the period, when it may become diurnally high. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period, with a rising slight chance toward the end of the forecast.

Figure 1: Solar Synoptic Map valid 22/2000 UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line ---, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms

There are two distinct CMEs within the forecast period, with a chance of further weak transients which have not appeared on imagery. The first was observed leaving the Sun's NE limb early on 19 Mar, possibly as a result of a filament eruption from the north-centre disc that occurred around 19/0034 UTC. ENLIL suggests a potential glancing blow at Earth late on 22 Mar. The second was a faint halo CME which was observed from near centre disc following the M1.2 flare from AR4028 at 21/1558 UTC. This has been analysed as a fast CME with speeds in the region 1000-1500km/s as it left the Sun, and is likely to arrive at Earth during the first half of day 1 (23 Mar) bringing solar winds speeds at L1 of 600-750 km/s. Given these potential CME influences, confidence in the forecast is lower than usual.

Otherwise, solar winds are expected to continue slightly elevated to elevated initially due to CH24/- influence, but are likely to become enhanced further with the CME arrival, perhaps reaching strong levels. Solar winds should then gradually decline through 24 and 25 Mar, before the potential arrival of the HSS from the large CH25/+ from late 25 into 26 Mar.

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Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	90	50	40	60
Strong	G3	No	50	5	5	10
Severe	G4	No	20	1	1	1
Extreme	G5	No	2	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R_☉ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
19/1121	Partial	Filament Eruption	North- centre	635	22/1900	Glancing blow from shock possible.
21/1830	Full Halo	M1.2/Filament	Centre	1200	23/0600	Faint so unlikely to be material-rich, but fast and possibly enhancing already fast winds and disturbed near earth environment.

Figure 2: MOSWOC Enlil showing the arrival of combined CME and CH HSS at 1AU during 23 Mar.

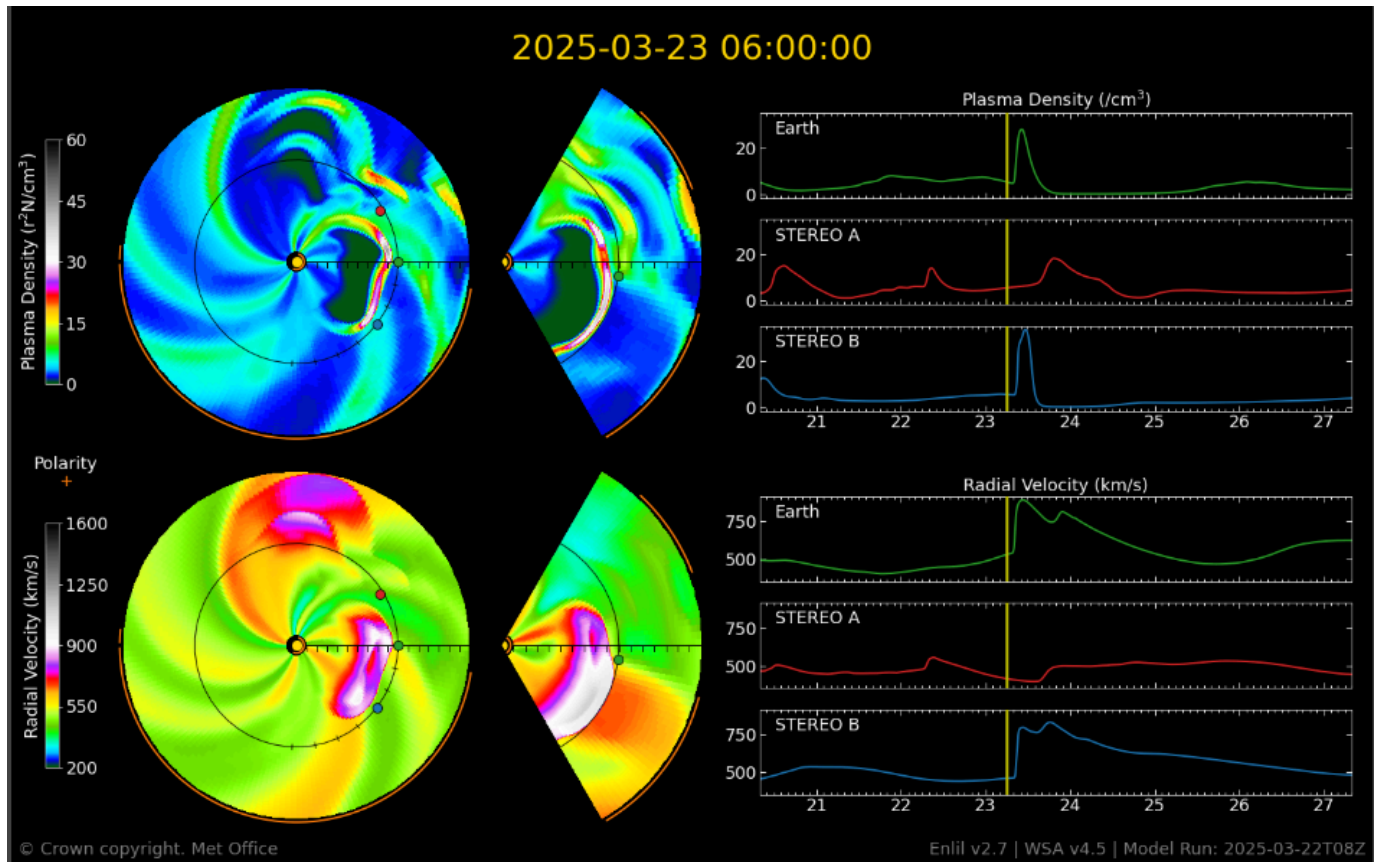
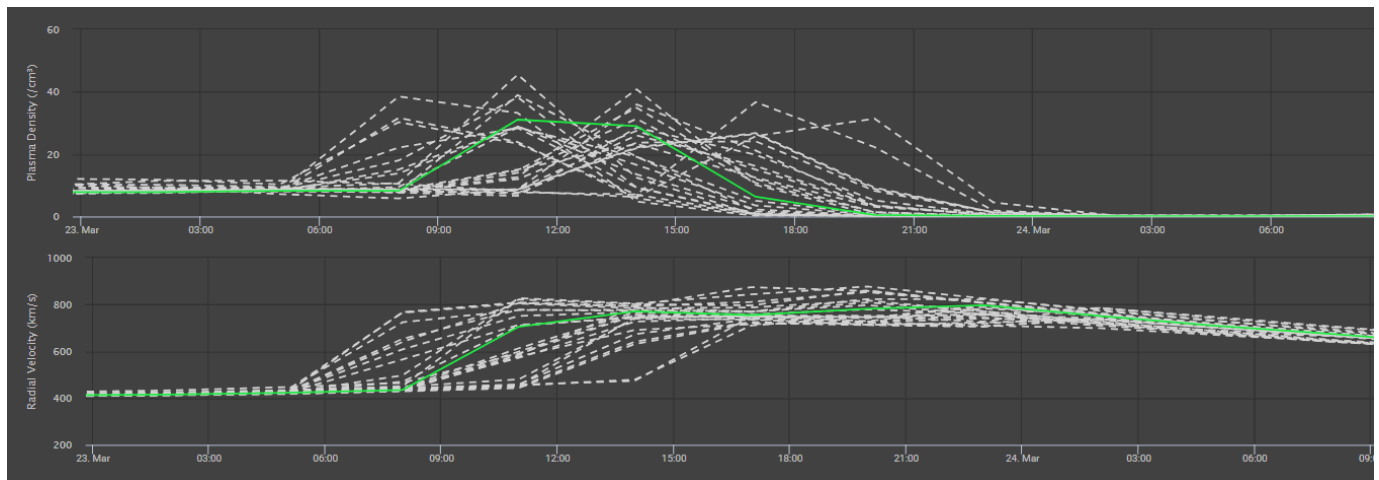


Figure 3: MOSWOC ENLIL ensemble.



Radio Blackouts - X-Ray Flares

Solar activity has been Low in the past 24 hours, with occasional C-flares.

There are currently thirteen sunspots on the Earth facing disc. Despite the large amount of sunspots, the vast majority are relatively small and magnetically simple and either stable or in slight decay. AR4036, in the northwest quadrant, remains the most significant group having displayed quite rapid growth in the past 24 hours, with multiple penumbra having developed in its trailing portion.

Generally Low activity is expected, with a chance of isolated M-class flares, on a generally flat trend through the next 4 days.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	35	35	35	35
Very Active	R3-R5 (X Class)	No	1	1	1	1

Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux was at background levels. Proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current lack of large, complex spot groups on the Earth facing disc.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons ($\geq 2\text{MeV}$)

GOES16 High energy ($>2\text{MeV}$) Electron flux was at background to moderate levels. With CME and CH HSS influences through the periods, flux levels are expected to remain at similar levels until later in the period, perhaps becoming diurnally high by day 4 (26 Mar).

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the remainder of the period, and is considered reasonable guidance, albeit with low confidence as a slightly increasing trend towards the end of the period is possible.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	10	20
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM fluence forecast/observations/recurrence.

